F 3104 (Pages : 3) Reg. No.....

Name.....

B.TECH. DEGREE EXAMINATION, NOVEMBER 2014

Third Semester

Branch—Electronics and Communication/Applied Electronics and Instrumentation/ Electronics and Instrumentation Engineering

SOLID STATE DEVICES (L A S)

(Prior to 2010 Admissions—Old Scheme)

[Supplementary/Mercy Chance]

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions briefly.*
Each question carries 4 *marks.*

1. Distinguish between direct and indirect bandgap semiconductors ? Give examples.
2. Explain the conduction process by holes.
3. List and briefly explain the properties of depletion region of a *pn* junction.
4. What are the differences between Zener and Avalanche breakdown ?
5. What is a varactor diode ? What are its applications ?
6. Draw the VI characteristics of a tunnel diode and label it.
7. Explain the doping profile in BJT and what is its significance.
8. What is Schottky transistor ? What are its applications ?
9. Define :
   (i) pinch-off voltage ; (ii) threshold voltage ;
   (iii) saturation voltage ; and (iv) breakdown voltage of a JFET.
10. What are the precautions to be taken while handling MOSFET ? Why ?

(10 × 4 = 40 marks)

Part B

Answer **all** *questions.*
Each full question carries 12 *marks.*

11. In a semiconductor at room temperature of 27°C, the intrinsic carrier concentration and resistivity are 1.5×10^{16} /m^3 and 2×10^3 Ωm respectively. It is converted to an extrinsic semiconductor with a doping concentration of 10^{20}m^3. For extrinsic semiconductor calculate :

Turn over

(a) Minority carrier concentration ;

(b) resistivity ;

(c) shift in Fermi-level due to doping ; and

(d) Minority carrier concentration when its temperature is raised to a value at which intrinsic carrier concentration doubles. Assume $\mu_n = \mu_p = 2000$ cm^2/Vs, kT = 26 mV at room temperature.

Or

12. (a) Derive the expression for the minimum conductivity of a semiconductor.

(b) Explain the transient decay of excess carriers in a semiconductor with direct recombination. Explain minority carrier life time.

13. In a p^+nn^+ junction diode, made of silicon the doping concentration of n-region is 5×10^{15} /cc. If the circuit field at avalanche breakdown is 3×10^5 V/cm, find :

(a) the breakdown voltage if the width of n-region is (i) 10 μm ; (ii) 5 μm ; (iii) 1 μm.

(b) Sketch and label the electric field distribution.

Or

14. Sketch the profiles and derive expressions for :

(i) build-in potential ;

(ii) electric - field distribution ;

(iii) depletion layer capacitance of a linearly graded p-n junction.

15. (a) Derive expression for the time variation of voltage across a p-n junction as it is switched from forward-bias to reverse-bias condition.

(8 marks)

(b) Draw the characteristics of a tunnel diode and explain.

(4 marks)

Or

16. (a) Derive the expression for conductance of a diode. How does it vary with variation in forward-bias ?

(b) What is Zener diode and how does it regulate the voltage ?

17. Plot the minority carrier distribution in a p-n-p BJT in all the three regions and label it properly for (i) active region ; (ii) cut-off region ; and (iii) saturation region.

Or

18. Draw the n-p-n and p-n-p transistors. Label all the currents when biased in active region and show the direction of carrier flow in both types of transistors ? Derive expressions for the current components.

19. A silicon MOS system with p-type substrate with $N_A = 10^{15}$/cc, oxide thickness = 100 Å, is at the onset of strong inversion. Determine :

    (a) width of depletion layer ;

    (b) the charge density in the depletion layer ;

    (c) the electron density n_s at the surface ; and

    (d) the threshold voltage. Assume $\epsilon_{rox} = 3.9$, $n_i = 1.5 \times 10^{10}$/cc.

Or

20. Derive expression for the drain current of JFET. What are the approximations made ? Explain the effect of increase in temperature on the drain current.

(5 × 12 = 60 marks)